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**Tension/compression testing
machines — Verification and
calibration of the force-measuring
system**

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Testing Machinery Association (JTM)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS B 7721 : 2002** is replaced with this Standard.

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Tension/compression testing machines— Verification and calibration of the force-measuring system

Introduction

This Japanese Industrial Standard has been prepared based on the third edition of **ISO 7500-1** published in 2004 without modifying the technical contents. The specification contents (normative reference and term) not provided for in the corresponding International Standard are added as **JIS** specification.

The portions with dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with explanations is given in Annex JA.

1 Scope

This Standard specifies the calibration and verification of tension and compression testing machines (hereafter referred to as "testing machines") used for assessment of mechanical strength characteristics of various kinds of materials.

NOTE 1 This Standard addresses the static verification of the force-measuring systems and the calibration values are not necessarily valid for high-speed or dynamic testing applications. Further information regarding dynamic effects is given in Bibliography.

NOTE 2 The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows :

ISO 7500-1 : 2004 *Metallic materials—Verification of static uniaxial testing machines—Part 1 : Tension/compression testing machines—Verification and calibration of the force-measuring system* (MOD)

The symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7728 *Calibration of force-proving instruments used for the verification of uniaxial testing machines*

NOTE : Corresponding International Standard : **ISO 376:1999** *Metallic materials—Calibration of force-proving instruments used for the verification of uniaxial testing machines* (MOD)

JIS Z 8103 Glossary of terms used in measurement

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in **JIS Z 8103** and the following apply.

3.1 calibration

operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication

NOTE 1 A calibration may be expressed by a statement, calibration function, calibration diagram, calibration curve, or calibration table. In some cases, it may consist of an additive or multiplicative correction of the indication with associated measurement certainty.

NOTE 2 Calibration should not be confused with adjustment of a measuring system, often mistakenly called "self-calibration", nor with verification of calibration.

NOTE 3 Often, the first step alone in the above definition is perceived as being calibration.

3.2 true force

force exerted on a force-proving instrument or force caused by weight

NOTE : This term is to be specifically discriminated from the "force" as indicated by the force-proving instrument.

4 Symbols and meanings

The symbols and meanings shall be in accordance with table 1.

Table 1 Symbols and their meaning

Symbol	Unit	Meaning
a	%	Relative resolution of the force indicator of the testing machine
b	%	Relative repeatability error of the force-measuring system of the testing machine
f_0	%	Relative zero error of the force-measuring system of the testing machine
F	N	True force caused by weight or indicated by the force-proving instrument with increasing test force
F'	N	True force caused by weight or indicated by the force-proving instrument with decreasing test force
F_c	N	True force or force indicated by the force-proving instrument with increasing test force, for the complementary series of measurements for the smallest range used

Table 1 (concluded)

F_i	N	Force indicated by the force indicator of the testing machine to be verified, with increasing test force
F_i'	N	Force indicated by the force indicator of the testing machine to be verified, with decreasing test force
$\bar{F}_i, \bar{F}$	N	Arithmetic mean of several measurements of F_i and F for the same discrete force
$F_{i \max}, F_{i \min}$ $F_{\max}, F_{\min}$	N	Highest or lowest value of F_i , or F for the same discrete force
F_{ic}	N	Force reading on the force indicator of the testing machine to be verified, with increasing test force, for the complementary series of measurements for the smallest range used
F_{i0}	N	Residual indication of the force indicator of the testing machine to be verified after removal of force
F_N	N	Maximum capacity of the measuring range of the force indicator of the testing machine
g_n	m/s ²	Local acceleration due to gravity
q	%	Relative accuracy error of the force-measuring system of the testing machine
r	N	Resolution of the force indicator of the testing machine
v	%	Relative reversibility error of the force-measuring system of the testing machine
ρ_{air}	kg/m ³	Density of air
ρ_m	kg/m ³	Density of the dead weights

5 General inspection of the testing machine

The verification of the testing machine shall only be carried out if the machine is in good working order. For this purpose, a general inspection of the machine shall be carried out before calibration of the force-measuring system of the machine (see Annex A and Annex B).

NOTE : Good metrological practice requires a calibration run prior to any maintenance or adjustments to the testing machine.

6 Calibration of the force-measuring system of the testing machine

6.1 General

This calibration shall be carried out for each of the force ranges used and with all force indicators employed. Any accessory devices (e.g. pointer, recorder) which may affect the force-measuring system shall, where used, be verified in accordance with 6.4.6.

If the testing machine has several force-measuring systems, each system shall be regarded as a separate testing machine. The same procedure shall be followed for double-piston hydraulic machines.

The calibration shall be carried out using force-proving instruments with the following exception. If the force to be verified is below the lower limit of the smallest capacity force proving device used in the calibration procedure, use known masses.

When more than one force-proving instrument is required to calibrate a force range, the maximum force applied to the smaller device shall be the same as the minimum force applied to the next force-proving instrument of higher capacity. When a set of known masses is used to verify forces, the set shall be considered as a single force-proving instrument.

The calibration should be carried out with constant indicated forces, F_i . When this method is not feasible, the calibration may be carried out with constant true forces, F .

NOTE 1 Calibration may be carried out with a slowly increasing force. The word "constant" signifies that the same value of F_i (or F) is used for the three series of measurements (see 6.4.5).

The instruments used for the calibration shall have a certified traceability to the international system of units (SI).

The force-proving instrument shall comply with the requirements specified in **JIS B 7728**. The class of the force-proving instrument shall be equal to or better than the class for which the testing machine is to be calibrated. In the case of dead weights, the relative error of the force generated by these weights shall be less than or equal to $\pm 0.1\%$.

NOTE 2 True force F (N) created by the dead weight of mass, m , in kilograms, is :

$$F = mg_n \left(1 - \frac{\rho_{\text{air}}}{\rho_m} \right) \dots\dots\dots (1)$$

This force can be calculated using the following approximate formula :

$$F = mg_n \dots\dots\dots (2)$$

The relative error of the force can be calculated, using the formula :

$$\frac{\Delta F}{F} = \frac{\Delta m}{m} + \frac{\Delta g_n}{g_n} \dots\dots\dots (3)$$

6.2 Determination of the resolution

6.2.1 Analogue scale

The thickness of the graduation marks on the scale shall be uniform and the width of the pointer shall be approximately equal to the width of a graduation mark.

The resolution, r , of the indicator shall be obtained from the ratio between the width of the pointer and the centre-to-centre distance between two adjacent scale graduation marks (scale interval). The recommended ratios are 1/2, 1/5 or 1/10, a spacing of 2.5 mm or greater being required for the determination of one-tenth of a scale division.